



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 10/664,947
Applicant : Jonah A. Harley, et al.
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I. REAL PARTY IN INTEREST

Agilent Technologies, Inc. is the real party in interest.

II. RELATED APPEALS AND INTERFERENCES

There are no other related appeals or interferences.

III. STATUS OF CLAIMS

Claims 1 and 3-24 are pending in the application. Claim 2 has been canceled. Claims 1 and 3-24 stand rejected. Applicants appeal the rejection of claims 1 and 3-24.

IV. STATUS OF AMENDMENTS

An amendment was filed subsequent to final rejection to correct dependency of claims 3-5. The Examiner issued an advisory action on October 21, 2005, indicating that the amendment does not place the application in condition of allowance. The Examiner later confirmed during a phone conference with Applicants' representative on December 1, 2005 that the amendment was entered.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Applicants have discovered a new, improved electrostatic stepping comb drive actuator that imposes discrete voltage patterns to achieve precise x-direction positioning. Prior art actuators have limited x-direction travel due to side instability, unilateral forces, and difficulty in precisely controlling x-direction motion. When a voltage difference is applied between the stator and the rotor, lateral electrostatic forces (*i.e.*, in the y-direction), as well as axial (*i.e.*, in the x-direction) are created. The lateral electrostatic forces act on each side of the rotor, and normally cancel. Prior art actuators also are problematic in that they provide analog positioning in which the positioning varies continuously with the applied voltage. The prior art does not provide the precise control needed in a micro-machined device. The applicants' new, improved electrostatic stepping comb drive actuator overcomes these problems.

All of the appealed claims are directed to embodiments of the new, improved electrostatic stepping comb drive actuator. Specifically, independent claim 1 is directed to an electrostatic stepping comb drive actuator that includes a first member 310, a second member 320, and voltage sources 330 and 350 (*e.g.*, p. 6, line 8 to p. 9, line 20; FIG. 2). The first member 310 includes a first tooth 321 and a second tooth 321 (*e.g.*, p. 6, lines 24-25; FIGS. 2 and 3D). Each tooth includes a first surface 322 or 323, first conductors 340, and a first electrode array 334 or 335, located on the first surface (*e.g.*, p. 7, line 22 to p. 8, line 20; FIG. 2). The first surface 322 of the first tooth is opposite the first surface 323 of the second tooth (*e.g.*, p. 7, lines 22-25; FIG. 2). The first electrode array 334 or 335 includes first electrodes 336 in a first electrode group (*e.g.*, p. 8, lines 8-12; FIGS. 2 and 3D). The first electrodes 336 in each of the first electrode groups are electrically connected to a same one of the first conductors 340 (*e.g.*, p. 8, line 21 to p. 9, line 4; FIGS. 2 and 3D).

The second member 310 includes a third tooth 311 interdigitated with the first tooth 321 and the second tooth 321 and movable in a direction of travel relative thereto (*e.g.*, p. 6, lines 19-25; FIGS. 2 and 3G). The third tooth 311 includes a second surface 312 or 313, disposed opposite each of the first surfaces 322 and 323, second conductors 318, and a second electrode array 315 located on the second surfaces (*e.g.*, p. 7, lines 22-25; p. 9, lines 5-13; FIGS. 2 and 3A). The second electrode array 315 includes second electrodes 316 in second electrode groups (*e.g.*, p. 9, lines 5-13; FIGS. 2 and 3A). The second electrodes 316 in each second electrode group are electrically connected to the same one of the second conductors 318 (*e.g.*, p. 9, line 5-13; FIGS. 2 and 3A). Voltage sources 350 and 330 impose

discrete voltage patterns on the first electrodes 336 and the second electrodes 316, respectively (e.g., p. 9, line 21 to p. 11, line 11; FIG. 4).

Independent claim 14 is directed to an electrostatic stepping comb drive actuator that includes a stationary member 310 having a tooth 311, a movable member 320, and voltage sources 330 and 350. The tooth 311 includes opposed surfaces 312 and 313, a first electrode array 315 disposed on the first surfaces 312 and 313, and a first conductor 318 coupled to the first electrode array 315. The movable member 320 includes second electrode arrays 334 and 335 disposed on surfaces (322 and 323) opposite the first surfaces 312 and 313, and second conductors 340 electrically connected to the second electrode arrays 334 and 335. The voltage sources 330 and 350 impose discrete voltage patterns on the first electrode array 315 and the second electrode arrays 334 and 335 (e.g., p. 6, line 4 to p. 11, line 11; FIGS. 2, 3A, 3D and 4).

Independent claim 22 is also directed to an electrostatic comb drive actuator that includes a tooth 311, an interconnected pair of coupled teeth 321, and voltage sources 330 and 350. The tooth 311 includes opposed first surfaces 312 and 313, and a first electrode array 315 located on the first surfaces 312 and 313. The first electrode array 315 includes first electrodes 316. The interconnected pair of coupled teeth 321 include second surfaces 322 and 323, opposite the first surfaces 312 and 313, respectively, and second electrode arrays 334 and 335 located on the second surfaces 322 and 323. The second electrode arrays include second electrodes 336. The voltage sources 330 and 350 impose discrete voltage patterns on the first electrodes 316 and the second electrodes 336 (e.g., p. 6, line 4 to p. 11, line 11; FIGS. 2, 3A, 3D and 4).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

(1) Claims 1, 3-7, 9, 14-17, 22 and 23 stand rejected under 35 U.S.C. § 103(a) as being obvious over Japanese Patent No. 07-274540 issued to Higuchi et al. (“Higuchi”) in view of U.S. Patent No. 5,869,916 issued to Suzuki et al. (“Suzuki-916”) (See August 16, 2005 Office Action (“Final Office Action”), p. 3, para. 6).

(2) Claims 8, 10-12 and 18-21 stand rejected under 35 U.S.C. § 103(a) as being obvious over Higuchi and Suzuki-916, and in further view of Japanese Patent No. 08-186987 issued to Suzuki et al. (“Suzuki-987”) (See Final Office Action, p. 4, para. 7) ; and

(3) Claims 13 and 24 stand rejected under 35 U.S.C. § 103(a) as being obvious over Higuchi and Suzuki 916, and in further view of U.S. Patent No. 5,986,381 issued to Hoen et al. (“Hoen”) (See Final Office Action, pp. 8-9, para. 8).

VII. ARGUMENT

The pending claims are patentable over the cited prior art. As noted above, the Final Office Action sets forth three grounds for rejection, all based on 35 U.S.C. § 103. Central to each of these grounds of rejection is the improper combination of Higuchi and Suzuki-916. The rejections set forth by the Examiner must fail because Higuchi and Suzuki-916 cannot be combined. These references, when considered as a whole, do not suggest the desirability of being combined. Rather, these references teach against making such a combination. The Final Office Action fails to indicate where sufficient motivation to overcome these teachings and combine Higuchi and Suzuki-916 can be found in the prior art. Since Higuchi and Suzuki-916 cannot be combined, the prior art references necessarily fail to teach or suggest all of the claim limitations and, therefore, fail to establish a *prima facie* case of obviousness. The pending claims must be allowed.

A. **Higuchi And Suzuki-916 Do Not Suggest The Desirability And Therefore The Obviousness Of Being Combined As Is Required By Law**

Claims 1, 3-7, 9, 14-17, 22 and 23 are rejected under 35 U.S.C. § 103(a) based solely on the improper combination of Higuchi in view of Suzuki-916. The Examiner seeks to combine Higuchi and Suzuki-916 because Higuchi does not teach “voltage sources that impose discrete voltage patterns on the first and the second electrodes,”¹ as recited in the claims, and Suzuki-916 purportedly does. See Final Office Action, p. 3, lines 7-16. To establish a *prima facie* case of obviousness ... the prior art reference (or references when combined) must teach or suggest all of the claim limitations. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). However, identification in the prior art of each individual part claimed in a patent is insufficient to defeat patentability of the whole claimed invention. *In re Kotzab*, 217 F.3d 1365, 1370 (Fed. Cir. 2000); *In re Rouffett*, 149 F.3d 1350, 1357 (Fed. Cir. 1998). Rather, in order to be combined, the references *must suggest* the desirability and thus the obviousness of making the combination. *Hodosh v. Block Drug Co., Inc.*, 786 F.2d 1136, 1143 n.5 (Fed. Cir. 1986) (Emphasis added); see, also, *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Indeed, prior art references must be considered in their entirety, *i.e.*, as a whole, including portions that lead away from the claimed invention. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984).

¹ As recited in independent claims 1 and 22. Recited as “voltage sources that impose discrete voltage patterns on the first and the second electrode arrays” in independent claim 14.

Higuchi and Suzuki-916 do not suggest the desirability of being combined. Higuchi generally describes electrostatic actuators that are conventional layered-type actuators driven by three-phase (or four-phase) circuit alternating current (*AC*) voltages (see paragraph [0039]). Suzuki-916, on the other hand, describes an electrostatic actuator having electrodes formed on a movable element and on a stator element driven by a direct-current (*DC*) voltage of fixed polarity applied to the movable element electrodes and a *DC* voltage of switched-over polarity applied to the stator element electrodes (see, *e.g.*, FIG. 1 and col. 7, lines 7-54). Suzuki-916 describes using a series of incremental *DC* voltages as a further driving force to smooth the movement of the movable element (see, *e.g.*, FIG. 3 and col. 8, lines 56-59). The Examiner argues to combine these *DC* voltages of Suzuki-916 with Higuchi in order to meet the claimed feature of “voltage sources that impose discrete voltage patterns on the first and the second electrodes.” See Final Office Action, p. 3, lines 16-19.

In other words, the Examiner proposes combining the *DC* power supply of Suzuki-916 with the three-phase (or four-phase) *AC* circuits of Higuchi. The mere fact that Higuchi’s actuators are driven by *AC* voltages teaches away from a combination with Suzuki-916 and its *DC* voltages. As is apparent to one of ordinary skill in the art, Suzuki-916’s *DC* voltages cannot be used to drive Higuchi’s three-phase (or four-phase) *AC* circuits. One cannot simply superimpose a *DC* power supply into an *AC* circuit. Furthermore, combining Higuchi and Suzuki-916 as proposed by the Examiner would render Higuchi unsatisfactory for its intended purpose and would drastically change the principle of operation of Higuchi.

It is well-settled law that if a combination of references would render the prior art being modified unsatisfactory for its intended purpose, then there is no suggestion to make the proposed combination. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984); see, also, MPEP 2143.01. Higuchi is specifically designed to use three-phase (or four-phase) *AC* voltages (see *e.g.*, paragraph [0001], “Field of Industrial Application...[t]he present invention relates to a layered-type electrostatic motor[s] driven by a 3-phase alternating current...,” see also, paragraph [0005] “Problems to be Solved by the Invention,” and paragraph [0039] “Advantages of the Invention.”). Even if one could replace the *AC* driving voltage of Higuchi with the *DC* voltages of Suzuki-916, this would render Higuchi’s invention unsatisfactory for its intended purpose. Modified as such, Higuchi would not be driven by an alternating current, as required and stated by its Field and throughout Higuchi. Indeed, modified as such, Higuchi would be inoperable in its intended Field in which *AC* is

the stated power supply. Consequently, Higuchi and Suzuki-916 teach against such a combination.

Furthermore, it necessarily follows from the above that the proposed combination would change the principle of operation of Higuchi. It is likewise well-settled law that if the proposed combination would change the principle of operation of prior art being modified, then the teachings of the references are *not* sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959); see, also, MPEP 2143.01. Even if one could replace the AC driving voltage of Higuchi with the DC voltages of Suzuki-916, Higuchi's system would have a DC principle of operation instead of the stated AC principle of operation. To emphasize, the Examiner's proposed modification would not change some incidental or immaterial aspect of Higuchi's operation. Rather, the Examiner's proposed modification would change an aspect of Higuchi's system that is at the heart of his invention (again, see Higuchi's "Field of Industrial Application" and throughout Higuchi's specification). As is well known to one of ordinary skill in the art, DC voltages are very different from AC voltages. Specifically, DC voltages have a "direct current" where the current is constantly applied in one direction. AC voltages have an "alternating current" where the current is applied in constantly changing, or rather, alternating directions. Since the combination would change the principle of operation of Higuchi, Higuchi and Suzuki-916 teach against such a combination and the claims are not *prima facie* obvious. As such, Applicants respectfully request that the rejection of claims 1, 3-7, 9, 14-17, 22 and 23 under 35 U.S.C. § 103(a) as being obvious over Higuchi in view of Suzuki 916 be vacated and reversed.

B. The Final Office Action Fails To Show, And Indeed Cannot Show, That The Proposed Motivation To Combine Higuchi And Suzuki-916 Is In The References

The Examiner argues that the motivation to combine Higuchi and Suzuki-916 is "to provide a smooth movement of the mover." *Id*, p. 3, lines 16-19. The law requires that the suggestion or motivation to combine must be in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991); *In re Rouffet*, 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1988). The Examiner fails to show that the alleged motivation to combine is in the references themselves. In fact, the Examiner cannot make such a showing since the alleged motivation to combine is not found in Higuchi and Suzuki-916. Moreover, the Examiner does not allege that the motivation to combine is in the knowledge generally

available to one of ordinary skill in the art. Without a proper motivation to combine, rejection of obviousness is improper. *Id.*

1. The Examiner Fails To Provide Support Showing That Higuchi Does Not Have A Smooth Movement

In order to show that the alleged motivation to combine is found in the references, the Examiner must provide support showing that Higuchi *does not* have “a smooth movement of the mover.” Suzuki-916 cannot *provide* “a smooth movement” to Higuchi if Higuchi already has a smooth movement; therefore, a showing of no “smooth movement” in Higuchi is required. The Examiner has failed to provide *any* support showing that Higuchi does not have a “smooth movement.” Indeed, there is no teaching in Higuchi that its movement is not smooth. Without such support, the Examiner has failed to show that the alleged motivation to combine is found in the references.

2. The Alleged Motivation To Combine Is Not Found In The References Themselves Because Higuchi Does Have A Smooth Movement

As noted above, Higuchi generally describes electrostatic actuators driven by AC voltages. As is apparent to one of ordinary skill in the art, these AC voltages produce a smooth movement. The moving force depends on the root mean square (rms) value of the applied AC voltage. The rms value of the AC voltage can be changed continuously and, therefore, an AC powered actuator will more likely provide smooth movement than a DC powered actuator with intermediate voltage levels. Since Higuchi already uses an AC voltage pattern that produces a smooth movement, there is no need and hence no motivation to replace the AC voltage of Higuchi with the DC voltages of Suzuki-916. In fact, one of ordinary skill in the art would recognize that if the AC voltage in Higuchi is replaced with the DC voltage pattern of Suzuki-916 cited by the Examiner, the movement of the mover in Higuchi will likely be *less* smooth. Since Higuchi already provides a smooth movement, the Examiner’s proposed motivation *cannot* be found in the references.

In fact, that an AC voltage source will produce a smooth movement is recognized by Suzuki-916 itself. Suzuki-916 also teaches an embodiment applying an AC voltage that provides a “smoothly varied” driving force and which *does not* apply the DC voltage pattern or DC intermediate voltages cited by the Final Office Action (see Suzuki-916 col. 16, lines 14-41). Since Suzuki-916 itself teaches that an AC voltage produces a smooth movement without the DC voltage pattern or DC intermediate voltages cited by the Final Office Action, the motivation to combine cannot be found in the references themselves.

Without a motivation to combine, rejection of the claims as obvious is improper. As such, Applicants respectfully request that the rejection of claims 1, 3-7, 9, 14-17, 22 and 23 under 35 U.S.C. § 103(a) as being obvious over Higuchi in view of Suzuki 916 be vacated and reversed.

C. Since Higuchi Cannot Be Combined With Suzuki-916, The Proposed Further Combination With Suzuki-987 Is Likewise Improper And Cannot Be Maintained

Claims 8, 10-12 and 18-21 are rejected as obvious over Higuchi and Suzuki-916 in further view of Suzuki-987. Since this rejection also relies on the improper combination of Higuchi and Suzuki-916, it also must fail for at least the same reasons provided above. Nothing in Suzuki-916 overcomes the teachings against combining found in Higuchi and Suzuki-987. Consequently, Applicants respectfully request that the rejection of claims 8, 10-12 and 18-21 are rejected as obvious over Higuchi and Suzuki-916 in further view of Suzuki-987 be vacated and reversed.

Moreover, the prior art teaches against combining Suzuki-987 with Higuchi. Suzuki-987 teaches connecting every other or every third electrode to a conductor to provide enhanced driving force with DC voltages (see FIG. 1 and Abstract). Since Higuchi is specifically designed to use three-phase (and four-phase) AC voltages, applying this connection pattern to Higuchi would render Higuchi unsatisfactory for its intended purpose and would change Higuchi's principle of operation. In addition, replacing the AC voltages of Higuchi with the DC voltage pulse of Suzuki-987 has the same inherent faults as discussed above with regards to Suzuki-916. Consequently, Applicants respectfully request that the rejection of claims 8, 10-12 and 18-21 are rejected as obvious over Higuchi and Suzuki-916 in further view of Suzuki-987 be vacated and reversed for these reasons as well.

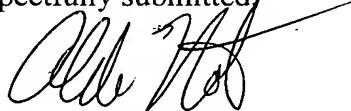
D. Since Higuchi Cannot Be Combined With Suzuki-916, The Proposed Further Combination With Hoen Is Likewise Improper And Cannot Be Maintained

Claims 13 and 24 are rejected as obvious over Higuchi and Suzuki-916 in further view of Hoen. Since this rejection also relies on the improper combination of Higuchi and Suzuki-916, it also must fail for at least the same reasons provided above. Nothing in Hoen overcomes the teachings against combining found in Higuchi and Suzuki-916. Consequently, Applicants respectfully request that the rejection of claims 13 and 24 are rejected as obvious over Higuchi and Suzuki-916 in further view of Hoen be vacated and reversed.

Moreover, Hoen is cited for teaching flexure suspension compliant in one direction and stiff in the direction orthogonal to travel. Such a suspension, which is commonly used

for MEMS actuators, simply does not apply to the large, layered-type actuators described by Higuchi (see paragraph [0002]; Higuchi's invention is designed to overcome disadvantages in conventional electric-type actuators which typically have heavy permanent magnets and coils. One of ordinary skill would recognize that Higuchi's conventional electric-type actuators are not MEMS type actuators). Consequently, Applicants respectfully request that the rejection of claims 13 and 24 are rejected as obvious over Higuchi and Suzuki-916 in further view of Hoen be vacated and reversed.

Respectfully submitted,



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Aldo Noto
Registration No. 35,628
ANDREWS KURTH LLP
1350 I Street, NW
Suite 1100
Washington, D.C. 20005
Telephone: (202) 662-3051
Fax: (202) 662-2739

CLAIMS APPENDIX

1. (Previously Presented): An electrostatic stepping comb drive actuator, comprising:
 - a first member comprising:
 - a first tooth and a second tooth each comprising:
 - a first surface, the first surface of the first tooth opposite the first surface of the second tooth;
 - first conductors, and
 - a first electrode array located on the first surfaces and comprising first electrodes in first electrode groups, the first electrodes in each of the first electrode groups electrically connected to a same one of the first conductors;
 - and
 - a second member comprising:
 - a third tooth interdigitated with the first tooth and the second tooth and movable in a direction of travel relative thereto, the third tooth comprising:
 - a second surface disposed opposite each of the first surfaces,
 - second conductors, and
 - a second electrode array located on the second surfaces, the second electrode array comprising second electrodes in second electrode groups, the second electrodes in each second electrode group electrically connected to the same one of the second conductors, and
 - voltage sources that impose discrete voltage patterns on the first and the second electrodes.
 2. (canceled)
 3. (Previously Presented): The actuator of claim 1, wherein the voltage pattern imposed on the first electrodes is a spatially alternating voltage pattern, wherein the voltage pattern imposed on the second electrodes is a spatially substantially alternating voltage pattern.
 4. (Previously Presented): The actuator of claim 1, wherein the voltage pattern imposed on the second electrodes is a spatially alternating voltage pattern, wherein the voltage pattern imposed on the first electrodes is a spatially substantially alternating voltage pattern.
 5. (Previously Presented): The actuator of claim 1, wherein the voltage pattern comprises a high voltage and a low voltage.
 6. (Original): The actuator of claim 5, wherein the voltage pattern comprises a third voltage intermediate between the high voltage and the low voltage.

7. (Original): The actuator of claim 1, wherein each first conductor is electrically connected to every third first electrode.
8. (Original): The actuator of claim 7, wherein each second conductor is electrically connected to every other of the second electrodes.
9. (Original): The actuator of claim 1, wherein each second conductor is electrically connected to every third second electrode.
10. (Original): The actuator of claim 9, wherein each first conductor is electrically connected to every other of the first electrodes.
11. (Original): The actuator of claim 1, wherein the first electrodes have a first pitch and the second electrodes have a second pitch different from the first pitch.
12. (Original): The actuator of claim 1, wherein the first electrode array comprises N first electrodes per unit distance and the second electrode arrays each comprise M second electrodes per unit distance, and wherein M is different from N.
13. (Original): The actuator of claim 1, further comprising a suspension that supports the first member and the second member relative to one another, and wherein the suspension is compliant in the direction of travel and is stiff in directions orthogonal to the direction of travel.
14. (Previously Presented): An electrostatic stepping comb drive actuator, comprising:
 - a stationary member having a tooth, the tooth comprising:
 - opposed surfaces, and
 - a first electrode array disposed on the first surfaces;
 - a first conductor coupled to the first electrode array;
 - a moveable member comprising second electrode arrays disposed on surfaces opposite the first surfaces; and
 - second conductors electrically connected to the second electrode arrays, and
 - voltage sources that impose discrete voltage patterns on the first and the second electrode arrays.
15. (Original): The actuator of claim 14, wherein the first conductor comprises N individual conductors, wherein the first electrode array comprises first electrodes, and wherein each of the N individual conductors is electrically connected to selected ones of the first electrodes.
16. (Original): The actuator of claim 15, wherein N equals three, wherein each of the N individual conductors is electrically connected to every third one of the first electrodes, and

wherein the first conductor imposes a spatially substantially alternating voltage pattern on the first electrode array.

17. (Original): The actuator of claim 16, wherein the spatially substantially alternating voltage pattern comprises at least one high voltage and at least one low voltage.

18. (Original): The actuator of claim 17, wherein each of the first electrodes is set at the high voltage or the low voltage, and wherein a voltage at selected ones of the first electrodes changes from the high voltage to the low voltage and a voltage at other selected ones of the first electrodes changes from the low voltage to the high voltage.

19. (Original): The actuator of claim 15, wherein each of the second conductors comprises M individual conductors, wherein each of the second electrode arrays comprises second electrodes, and wherein each of the M individual conductors is electrically connected to selected ones of the second electrodes.

20. (Original): The actuator of claim 19, wherein each of the M individual conductors is electrically connected to every second one of the second electrodes.

21. (Original): The actuator of claim 19, wherein the first electrodes have a first pitch and the second electrodes have a second pitch different from the first pitch.

22. (Previously Presented): An electrostatic comb drive actuator, comprising:
a tooth, comprising:

opposed first surfaces, and

a first electrode array located on the first surfaces, the first electrode array comprising first electrodes;

an interconnected pair of coupled teeth, comprising:

second surfaces opposite the first surfaces, and

second electrode arrays located on the second surfaces, the second electrode arrays comprising second electrodes, and

voltage sources that impose discrete voltage patterns on the first and the second electrodes.

23. (Original): The electrostatic stepping comb drive actuator of claim 22, further comprising means for imparting discrete movement steps to the second member.

24. (Original): The actuator of claim 22, further comprising a suspension, wherein the tooth and the second interconnected pair of coupled teeth are supported relative to one another and wherein the suspension is compliant in a first direction and is stiff in directions orthogonal to the first direction.

EVIDENCE APPENDIX

No evidence submitted.

RELATED PROCEEDINGS APPENDIX

No related proceedings.